APPENDIX 1: THE LABORATORY IN THE NEWS

The following pages contain news articles and press releases that describe some of the Laboratory's activities during 2006.

Space network to track rainfall

By Richard Black

Environment Correspondent, BBC News Web site, in Vienna

The US and Japanese space agencies (NASA and Jaxa) are to launch a satellite network to measure rainfall around the world.

The Global Precipitation Measurement (GPM) project will provide three-hourly reports on rainfall.

It aims to improve weather forecasting and understanding of how the global water cycle affects climatic change.

Details of the $1.1bn (£636m) project, due to begin in 2011, were presented at a conference in Vienna, Austria.

"The aim is to provide the best possible global precipitation measurement available from any sources," said Arthur Hou, GPM project scientist at Nasa's Goddard Space Flight Center near Washington DC.

"It is primarily a science mission, but folded into the science objectives is to improve algorithms for weather forecasting," he told the BBC News Web site.

"It will help with climate, because rainfall is a fundamental element in the climate, and also measuring soil moisture feedback would improve climate prediction."

Higher resolution measurement in the future may also help forecast floods and landslides.

'Satellites of opportunity'

The heart of the GPM will be a "core" satellite equipped to measure rainfall in two ways, via a dual-frequency radar and a passive microwave radiometer.

It will also serve as a calibration reference for the rest of the satellite constellation.

These will come from a range of space agencies. Some will be designed explicitly for GPM, others "satellites of opportunity", launched for other projects but capable of putting data into the GPM system.

Between six and eight satellites will be involved altogether; using a range of instruments and in a variety of orbits, the idea is to provide a constantly-updated picture of rainfall around the world.

It extends a previous US-Japanese collaboration, the Tropical Rainfall Measuring Mission.

"This takes it from the tropics to a global extent," said Dr. Hou, "and also will enable us to measure lower rain rates as well as snow."

Dr. Hou's presentation formed part of a sequence here at the European Geosciences Union (EGU) meeting on improving measurement of rainfall.

There was general agreement that better data was badly needed, particularly for rain over the oceans, where surface-based measurement was not easy.

Eyal Amitai, also from Goddard Space Flight Center with an additional post at George Mason University in Washington DC, is working on a new detection method involving sound.

"It is difficult to measure rainfall at sea," he said. "Rain gauges on board ships and on surface moorings are unstable and subject to vandalism; satellite observations are poor in temporal coverage and have large spatial averaging, whereas rain

is highly variable in time and space."

During 2004, Dr Amitai's team conducted experiments with hydrophones - underwater sound detection devices - in the Ionian Sea.

By calibrating their observations against radar observations, they concluded that placing hydrophones one or two kilometres underwater could be an effective way to measure rainfall on the sea.

Story from BBC NEWS:

http://news.bbc.co.uk/go/pr/fr/-/1/hi/sci/tech/4872606.stm

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April 7, 2006

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CONTRACT RELEASE: C06-022

NASA AWARDS LABORATORY FOR ATMOSPHERES CONTRACT

NASA has selected Science Systems and Applications, Inc., Lanham, Md., for the Laboratory for Atmospheres Scientific and Technical Support Services contract.

The award is a five-year cost-plus award fee, indefinite delivery-indefinite quantity contract with a maximum value of $45 million. The work will be performed at NASA's Goddard Space Flight Center, Greenbelt, Md., and at the contractor's facility in Lanham.

The work includes scientific and technical support to three branches in the Laboratory for Atmospheres. The work involves using observations from NASA satellites to derive such important scientific and weather parameters as global rainfall distribution and the year-to-year trends of atmospheric ozone levels.

Also included in the contract is instrument development, such as state-of-the art lasers that accurately determine the vertical profiles of aerosols, clouds and water vapor in the atmosphere. Other scientific support includes numerical modeling of hurricane and cloud systems, the transport of trace gases and modeling to determine the role of aerosols and clouds on climate.

For information about NASA and agency programs, visit: http://www.nasa.gov/home

April 11, 2006

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RELEASE: 06-182

NASA EARTH SCIENCE EXHIBITS OPEN IN SMITHSONIAN MUSEUM

NASA has announced two new exhibits, "Atmosphere: Change in the Air" and "Arctic: A Friend Acting Strangely," opening April 15 at the Smithsonian National Museum of Natural History in Washington. The exhibits, part of the museum's "Forces of Change" series, feature scientific data from NASA and other agencies on the Earth's changing climate.

Scientists from NASA's Goddard Space Flight Center in Greenbelt, Md., contributed movies, interactive computer data, and stunning satellite images to launch the two exhibits.

"Atmosphere: Change in the Air" focuses on the Earth's atmospheric composition and chemistry. The latest results from NASA's Aura satellite, the third in series of large Earth-observing satellites, are featured.

Ernest Hilsenrath, atmospheric scientist at NASA Headquarters, Washington, said, "The 'Atmosphere' exhibit highlights the research NASA is conducting to better understand the connection between atmospheric composition and climate change. We hope this exhibit will enhance the public's awareness of how unique our atmosphere is and the impact humans can have on our global environment."

Visitors can learn about these changes through several movies. The first movie takes the viewer from space through the solar system, highlighting the atmospheres of each planet. It ends on Earth in Washington, D.C. with a zoom in to the National Mall. The second movie is a lighthearted description of oxygen's tendency to oxidize, or react with other molecules, which is how fires, rust and the ozone in air pollution are generated. Ground-level ozone also acts as an oxidizer and is harmful to human and ecosystem health. A third movie takes the viewer on a journey over 20 years to see how the ozone hole over Antarctica has changed.

The exhibit features an interactive computer, where visitors learn how changes in oxygen, carbon dioxide and ozone amounts can affect the Earth. Visitors see how carbon dioxide and ground-level ozone are associated with fossil fuel combustion and affect the air we breathe. Ozone near the Earth is a pollutant and a component of smog. Ozone high in the atmosphere protects life on Earth from the sun's harmful ultraviolet radiation. Amounts of this ozone have been in decline due to the release of ozone-destroying chemicals.

Satellite images from NASA's Aura satellite show visitors how pollution travels around the world. The images show how great dust storms crossing the Atlantic and Pacific oceans can affect air quality far from their sources. The exhibit also includes specimens from the museum's paleobiology and meteorite collections.

NASA and the National Oceanic and Atmospheric Administration (NOAA) both contributed information to "Arctic: A Friend Acting Strangely," the second exhibit in the "Forces of Change" gallery. This exhibit shows how a changing climate has affected Arctic temperatures, sea ice and area life.

Much of the data and material for the images were provided by scientists at NASA and those in academia whose research is supported by NASA. "Satellite capabilities provide an important perspective for understanding how the Arctic is changing," said Dr. Waleed Abdalati, head of the Cryospheric Sciences Branch at Goddard, who reviewed materials for the exhibit. "By providing new views of the entire Arctic against the backdrop of the larger Earth system, we provide a new appreciation and context for how this cold and remote region fits into the global picture."

NOAA offered support for the exhibit and worked closely with the Smithsonian Institution to frame the content and

develop specific topics and materials. The exhibit also explores how changes in the Arctic are monitored by scientists and polar residents. Visitors will see the challenges scientists face while working in extreme conditions and some of the technology that helps gather critical data to monitor changing conditions.

Visitors will also see objects from the Smithsonian's anthropology collections, photographs, scientific data such as the Arctic temperature record from 1900 to the present day, and a 2-3 minute video, "Eyewitness to Change." The video takes visitors to the Inuit community of Sachs Harbour in the Canadian Arctic. Residents discuss climate changes and how they have affected their lives. The exhibit is also funded in part by the National Science Foundation.

For more information about this exhibition the Web, visit:

http://www.mnh.si.edu/

For more information about NASA and agency programs on the Web, visit: http://www.nasa.gov/home

May 24, 2006

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RELEASE: 06-231

NEW SPACE OBSERVATIONS POISED TO SAVE LIVES FROM FLOODS, LANDSLIDES

Using NASA's advanced Earth-observing satellites, scientists have discovered a new opportunity to build early detection systems that might protect thousands from floods and landslides.

This potential breakthrough in disaster monitoring and warning links satellite observations of soil type, vegetation and land slope with observations of rainfall, rivers and topography.

"Flood and landslides are the most widespread natural hazards on Earth, responsible for thousands of deaths and billions of dollars in property damage every year," said Bob Adler, project scientist for the Tropical Rainfall Measuring Mission at NASA's Goddard Space Flight Center, Greenbelt, Md., and lead scientist of one of four projects that share a similar focus. "Between 1985 and 2000 over 300,000 people lost their lives to flooding and their associated landslides. Currently, no system exists at either a regional or a global scale to monitor rainfall conditions that may trigger these disasters."

"Our use of space as a vantage point to better understand floods and landslides will enable agencies and other public officials charged with doing so to actually apply what we're learning in ways that will make a tangible difference in a lot of lives all over the world," said Yang Hong, a research scientist at Goddard and lead scientist of one of the research

projects. The research used data from several NASA satellites -- the Tropical Rainfall Measuring Mission, Aqua, the Shuttle Radar Topography Mission, QuikSCAT and Earth Observing-1 -- and NOAA's Geostationary Operational Environmental satellites.

The havoc of landslides and floods is felt most acutely in parts of the world without extensive flood and rainfall monitoring ground networks.

Scientists approached the study of how satellite remote sensing can be applied to create flood and landslide detection from several angles. Space-based remote sensing allows scientists to look at the whole earth from above, improving their understanding of how Earth's system components behave and interact with each other.

Robert Brakenridge and his colleagues at Dartmouth College, Hanover, N.H., are using satellite microwave sensors to estimate water discharge from rivers by measuring almost daily changes in river widths.

"This month much of New England suffered from its worst flooding since 1936, causing governors in several states to declare states of emergency," said Brakenridge. "Satellite observations can be absolutely essential in lessening the severity on the local economies and possible injuries in such future occurrences if they can be galvanized to create more reliable warning systems."

Kwabena Asante, a senior scientist at U.S. Geological Survey in Sioux Falls, S.D., led research that puts forward an innovative method of mapping floods around the globe using a combination of data from NASA's Tropical Rainfall Measuring Mission and the Shuttle Radar Topography Mission. This new development could offer a practical solution to the significant challenge of creating cost-effective early warning systems particularly needed in data scarce, rural areas.

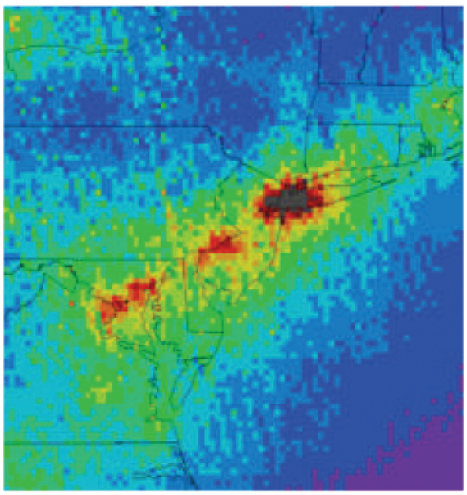
Researchers are presenting findings today during the American Geophysical Union meeting in Baltimore, Md. For information, images, and research abstracts from today's news briefing, visit:http://www.nasa.gov/vision/earth/lookingatearth/springagu_2006.html

National Aeronautics
and Space Administration

Washington Getting a Summertime Air Quality Exam 0 8.03.06

Summer in the city can often mean sweltering 'bad air days' that threaten the health of the elderly, children and those with respiratory problems. This summer the nation's capitol has been no stranger to such severe air-quality alerts.

Image below: NASA's Aura satellite can see several different forms of air pollution worldwide. This image shows high levels of nitrogen dioxide on the U.S. East Coast in 2005. Credit: NASA



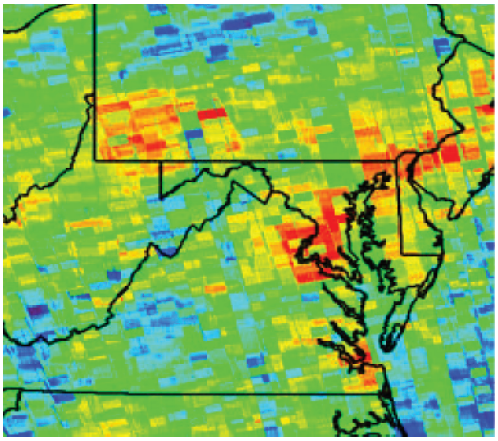
But since early July Washington area skies have been put under a unique microscope as scientists from NASA and around the country assembled a powerful array of scientific instruments -- in space and on the ground -- to dissect the region's atmosphere. The result will be not only a better understanding of intense urban air pollution episodes but also a better toolkit to track and probe air pollution worldwide from space.

Two years ago NASA launched the third of its major Earth Observing System satellites --Aura -- carrying a group of instruments designed to take global measurements of air pollution on a daily basis. Aura sensors can detect five of the six air pollutants regulated by the U.S. Environmental Protection Agency. But to make these 400-mile-high readings as accurate as possible, data from the sophisticated Aura instruments need to be compared to data from tried-and-true sensors on Earth.

NASA is sponsoring just such a 'ground-truth' experiment this summer. Howard University Research Campus, Beltsville, Md., is hosting visiting scientists, graduate students and instruments for a six-week-long series of intensive observations. The experiment is also evaluating the next generation of instruments used in daily weather forecasting, as well as tracking one of the strongest greenhouse gases involved in climate change: water vapor, which at increased levels we feel as humidity.

The Beltsville research facility grew out of collaborations between NASA, the National Oceanic and Atmospheric Administration (NOAA), and Howard University in Washington.

Image below: NASA's Aura spacecraft captured high summertime levels of the air pollutant nitrogen dioxide in the Washington metropolitan area last month. This image combines several Aura views from July 13-20. Nitrogen dioxide plays a key role in the formation of ground-level ozone pollution. Credit: NASA



The site is dotted with instruments from the National Weather Service, the Maryland Department of the Environment, and a local television station. For this summer's experiment, additional sensors have been brought in from NASA's Goddard Space Flight Center, Greenbelt, Md.; NASA's Wallops Flight Facility, Wallops Island, Va.; Pennsylvania State University, University Park; University of Colorado, Boulder; and Trinity University, Washington. Students from many of these institutions, as well as the University of Wisconsin, Madison, and Smith College, Northampton, Mass., are involved in the day-to-day operations.

'With a large collaboration like this you can really investigate a lot of interesting aspects of air quality,' says David Whiteman, who is leading Goddard's research team from the nearby NASA center. 'You can look straight down through the atmosphere to the ground from the satellite and at the same time you see in great detail the whole chemical soup of pollutants near the surface from the state's air quality monitoring site located here. Multi-instrument observations like this make the Howard site a real gem.'

The experiment is also focusing on a key measurement for both global climate change and local weather forecasting: water vapor. 'Measuring water vapor is a tricky business, because it varies greatly in quantity around the globe,' says Whiteman. But if our Earth is indeed warming, we need to understand how water vapor responds to that. Water vapor is a stronger greenhouse gas than carbon dioxide and could have a major impact on future climate.'

Water vapor measurements from NASA's Aura satellite and its companion Aqua, launched in 2002, are being compared with readings at the site from several laser-based instruments called lidars that can continuously observe water vapor levels in great detail directly overhead. In addition, balloon-borne instruments called radiosondes, a standard instrument used daily around the world, are being flown to compare their accuracy with the more sophisticated research tools.

'The moisture information we get every day from radiosondes is becoming more important in numerical weather prediction and climate monitoring,' says Joe Facundo, chief of the National Weather Service's Observing Systems Branch, who is participating in the Beltsville experiment. 'This type of instrument comparison project lets us test improved moisture sensors. 'Better water vapor data from radiosondes flown around the world can lead to more accurate weather forecasts and long-term climate predictions.

New knowledge is also emerging from the experiment about the daily rise and fall of ozone pollution, which involves a complex interplay between the 'chemical soup' of pollutants, sunlight, and meteorology. 'We have already observed examples of the influence of a narrow stream of strong winds during the night on surface-level ozone formation,' says Howard's Everette Joseph, who leads the university's team of scientists and students. "Better understanding of this process could lead to better air quality forecast methods and aid local governments in developing strategies to combat ozone pollution."

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Find this article at: http://www.nasa.gov/centers/goddard/news/topstory/2006/washington_air.html

July 13, 2006

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RELEASE: 06-278

NASA EXPLAINS PUZZLING IMPACT OF POLLUTED SKIES ON CLIMATE

NASA scientists have determined the formation of clouds is affected by the lightness or darkness of air pollution particles. This also impacts Earth's climate.

In a breakthrough study published Thursday in the online edition of Science, scientists explain why aerosols -- tiny particles suspended in air pollution and smoke -- sometimes stop clouds from forming and in other cases increase cloud cover. Clouds deliver water around the globe, and they also help regulate how much of the sun's warmth the planet holds. The capacity of air pollution to absorb energy from the sun is the key.

"When the overall mixture of aerosol particles in pollution absorbs more sunlight, it is more effective at preventing clouds from forming. When pollutant aerosols are lighter in color and absorb less energy, they have the opposite effect and actually help clouds to form," said Lorraine Remer of NASA's Goddard Space Flight Center, Greenbelt, Md. Remer worked closely with the study's lead author, the late Yoram Kaufman of Goddard, on previous research into this perplexing "aerosol effect."

With this new understanding, scientists working to predict how the Earth's climate is changing will be able to take a big step forward. The effect of the planet's constantly changing cloud cover has long been a problem for climate scientists. How clouds change in response to greenhouse-gas warming and air pollution will have a major impact on future climate.

Using this new understanding of how aerosol pollution influences cloud cover, Kaufman and co-author Ilan Koren of the Weizmann Institute in Rehovot, Israel, estimate the impact world-wide could be as much as a 5 percent net increase in cloud cover. In polluted areas, these cloud changes can change the availability of fresh water and regional temperatures.

In previous research by the authors and their colleagues, both effects that aerosols have on clouds were seen with data from NASA satellites. Over the northern Atlantic Ocean, clouds that often produce heavy rain storms grew taller and were more frequent when plumes of pollution from North America or dust from Africa's Sahara Desert were present. However, when smoke from large fires billowed into the sky over South America's Amazon River basin, clouds were consistently fewer than when the air was relatively clear.

With these observations alone, the scientists could not be absolutely sure the aerosols themselves were causing the clouds to change. Other local weather factors such as shifting winds and the amount of moisture in the air could have been responsible, meaning the pollution was just along for the ride.

"Separating the real effects of the aerosols from the coincidental effect of the meteorology was a hard problem to solve," Koren said. In addition, the impact of aerosols is difficult to observe, compared to greenhouse gases like carbon dioxide, because aerosols only stay airborne for about one week, while greenhouse gases can linger for decades.

To tackle this problem, Kaufman and Koren assembled a massive database of global observations that strongly suggests it is the darkness (absorbs sunlight) or brightness (reflects sunlight) of aerosol pollution and not weather factors that cause pollution to act as a cloud killer or a cloud maker. These measurements were culled from the NASA-sponsored Aerosol Robotic Network of ground-based instruments at nearly 200 sites worldwide.

The scientists conducted an extensive survey of sky conditions at 17 locations (including Washington, Rome, Beijing,

and Mexico City) that represented different types of air pollution and weather patterns. Automated instruments that act like a camera's light meter to record how much sunlight was coming from the sky took readings several times an hour at different times of the year.

No matter where in the world the measurements were taken or in what season, Kaufman and Koren saw the same pattern. There were lots of clouds when light-reflecting pollution filled the air, but many fewer clouds were recorded in the presence of light-absorbing aerosols. "The probability that such a consistent relationship between aerosols and their effects on clouds is due to some other factor is very unlikely," Koren said.

NASA's satellites, computer models, and technology will continue to advance our understanding of how aerosol pollution affects the Earth's climate. NASA's formation of flying satellites, with the cloud-piercing instruments onboard the Cloudsat and CALIPSO spacecraft, are helping answer challenging questions such as the role of clouds in global warming and the influence of aerosols on rainfall and hurricanes.

For more information, visit: http://www.nasa.gov/vision/earth/environment/pollution_clouds.html

Rainy Days Driven by Traffic Patterns, Study Says

Richard A. Lovett
for National Geographic News
July 13, 2006

Think it rains only on the weekend? Not if you live in the Southeast United States. Summer rainfall in this region of the country appears to mimic the highs and lows of air pollution from weekday commuters, says Thomas Bell of the NASA Goddard Space Flight Center in Greenbelt, Maryland.

At the May meeting of the American Geophysical Union in Baltimore, Maryland, Bell reported that afternoon thundershowers are more frequent and more intense on weekdays than on weekends. Bell limited his study to summer thunderstorms, which, in theory, are most likely affected by changes in air pollution. Meteorologists believe smog contains tiny particles that spur the formation of water droplets, which eventually become raindrops. More smog, therefore, not only means more droplets, but also tinier ones—at least in the initial stages of storm formation. These smaller droplets are carried higher into the air before falling as rain, which ultimately increases storm intensity.

Wednesday Thunderstorms

Scientists have long speculated that pollution from weekday commuters might affect the storm cycle. But previous studies failed to detect a link. Bell says that past studies tended to focus on individual cities, particularly those in coastal areas where other factors may also influence storms. Seeking to examine the issue more broadly, Bell analyzed rainfall patterns from nine years of satellite data from the Southeast quadrant of the U.S. The region extends as far north as central Illinois and as far west as mid-Texas. The scientist found that during June, July, and August afternoon thunderstorms were most common on Wednesdays and least common on weekends. The showers exactly mirrored pollution intensity from vehicle traffic. According to the satellite data, midweek afternoon rainfall was nearly double weekend precipitation. Weekday storms were also more likely to be intense downpours.

Driving Patterns

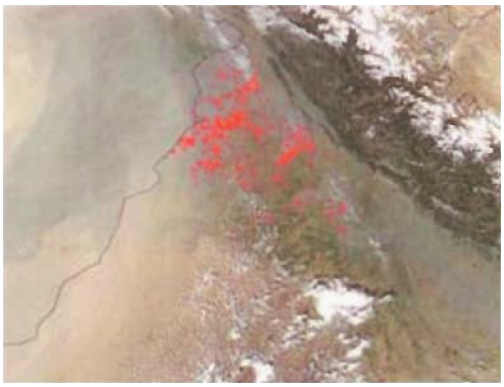
Bell and his colleagues say that atmospheric wind-speed data also indicate that stronger and more frequent storms occur on weekdays. Local weather station rainfall measurements backed the team's findings. Bell believes weekday commuter car traffic is unlikely to be the sole cause of the summer weather pattern. While people change their driving pattern on weekends, they still drive, he says. Monitoring by the U.S. Environmental Protection Agency has found that air pollution levels follow weekly cycles marked by mid-week peaks. But there appears to be only a 10 to 15 percent dip in pollution on weekends. Bell doesn't believe commuter car traffic alone is enough to explain the rain effect found by his study. "Truck traffic drops off a lot on weekends," the researcher said. "So it might be something related to pollution from truck traffic. But that's a pure guess."

National Aeronautics and Space Administration

Hot Dust and Moisture Collide to Fuel Asian Summer Rainy Season 09.07.06

Who would think that something like dust in the air could trigger rain? According to a new NASA study, this is just what's happening over South Asia's Tibetan Plateau. Very small dust particles called aerosols blow in from desert regions and collect in the atmosphere over the plateau's slopes early in the region's monsoon season, helping trigger rainfall.

Image below: Dust and smoke from fires (red points) over northwestern India/Pakistan may contribute to a change in rainfall patterns over the region. Credit: NASA



A monsoon is a seasonal shift in wind direction that alternately brings very wet and then very dry seasons to India and much of Southeast Asia.

William Lau, research scientist at NASA's Goddard Space Flight Center, Greenbelt, Md. and his team studied the aerosols using computer models. They found aerosols in the form of dust lofted from the desert surface and transported to the monsoon region can heat the air by absorbing the sun's radiation, altering the Asian monsoon water cycle. Black carbon particles from industrial emissions, bio-fuel burning and forest fires can add to this warming effect by absorbing the sun's radiation and heating the air currents transporting those aerosols. In some instances, black carbon coats the dust amplifying the heating effect because black carbon absorbs solar radiation more efficiently than dust. Rains from this annual weather cycle are a lifeline to over 60 percent of the world's population. Up to now, scientists have understood very little about how aerosols interact with the atmosphere to influence monsoons. Lau's computer simulations indicate both of these light-absorbing and heat emitting aerosols, when mixed together with warm air currents and moisture, cause a heating effect in the air, triggering the rainy season earlier than usual and lengthening the wet monsoon season in Asia. The study was published the May 2006 issue of Climate Dynamics.

Image below: Space Shuttle view of haze and pollution over Northern India swept in from Tibet. Credit: NASA

Appendix 1: The Laboratory in the News

"Traditionally, aerosols have been seen as only a local environmental problem. Until very recently, aerosols have not been viewed as an intervening presence in the atmosphere that could affect monsoon rains," said Lau. "This study is the first to link dust aerosols to monsoon rainfall changes and to claim a specific physical mechanism in the atmosphere, whereby the tiny dust particles interact with the monsoon heat and moisture."

The mechanism operates like an "elevated heat pump," according to Lau.

Increased dust aerosols blowing in from western China, Afghanistan, Pakistan and the Middle East coupled with black carbon emissions from northern India accumulate in the pre-monsoon late spring in the atmosphere over the northern and southern slopes of the Tibetan Plateau. When the dust absorbs the sun's radiation, it heats the surface air hovering above the mountainous slopes of the region. The heated air rises and draws warm, moist air in to northern India from the Indian Ocean, which helps create more rainfall. As the air warms and moves upward, new air is drawn in to take its place, which is also warmed - creating a process like a pump that pulls heated air upwards.

The "heat pump" effect actually starts the wet monsoon season prematurely in northern India, leading to a longer rainy season.

The rising motion associated with the "elevated heat pump" effect far above the ground will shift the monsoon's path toward the foothills of the Himalayas, meaning that more rain will fall earlier in the season (in May) in northern India as a result, and less over the Indian Ocean to the south. The intensified heat and rain may cause increased mountain glacier melt, leading to more erosion in Nepal and near the Ganges River.

"An improved understanding of the effects of aerosols on the monsoon seasonal cycle benefits both science and society," said Lau. "Understanding the relationship between aerosols and the cycle of rainfall has a potential impact on water resources all over the globe."

Lau and colleagues from Kongju National University in Gongju, Korea, and Science Systems and Applications, Inc. of Lanham, Md., included the occurrence of these light-absorbing and heat-emitting dust and black carbon aerosols in their computer simulation with wind, moisture, and rainfall to see how they would interact. "We've looked at the evolution of monsoons over a 10-year period. We're definitely seeing something new through this model," commented Lau.

According to Lau, most studies of monsoons are done first by way of observations. In this case, because of the lack of long-term aerosol information and the complicated nature of the monsoon climate system, the researchers concentrated on computer modeling first. They now plan to confirm their findings with observations from satellites and from NASA's Aerosol Robotic Network, more commonly known as AERONET, a global network of ground-level aerosol sensors. AERONET instruments will be deployed in Nepal for this research.

Lau's research team is currently examining the aerosol effect on rainfall over South America and West Africa, where they are also finding that the "elevated heat pump" mechanism seems to be at work.

Gretchen Cook-Anderson, NASA Goddard Space Flight Center

Find this article at: http://www. nasa.gov/centers/goddard/centers/topstory/2006/asian_rain.html

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RELEASE: 06-338

NASA AND NOAA ANNOUNCE ANTARCTIC OZONE HOLE IS A RECORD BREAKER

NASA and National Oceanic and Atmospheric Administration (NOAA) scientists report this year's ozone hole in the polar region of the Southern Hemisphere has broken records for area and depth.

The ozone layer acts to protect life on Earth by blocking harmful ultraviolet rays from the sun. The "ozone hole" is a severe depletion of the ozone layer high above Antarctica. It is primarily caused by human-produced compounds that release chlorine and bromine gases in the stratosphere.

"From September 21 to 30, the average area of the ozone hole was the largest ever observed, at 10.6 million square miles," said Paul Newman, atmospheric scientist at NASA's Goddard Space Flight Center, Greenbelt, Md. If the stratospheric weather conditions had been normal, the ozone hole would be expected to reach a size of about 8.9 to 9.3 million square miles, about the surface area of North America.

The Ozone Monitoring Instrument on NASA's Aura satellite measures the total amount of ozone from the ground to the upper atmosphere over the entire Antarctic continent. This instrument observed a low value of 85 Dobson Units (DU) on Oct. 8, in a region over the East Antarctic ice sheet. Dobson Units are a measure of ozone amounts above a fixed point in the atmosphere. The Ozone Monitoring Instrument was developed by the Netherlands' Agency for Aerospace Programs, Delft, The Netherlands, and the Finnish Meteorological Institute, Helsinki, Finland.

Scientists from NOAA's Earth System Research Laboratory in Boulder, Colo., use balloon-borne instruments to measure ozone directly over the South Pole. By Oct. 9, the total column ozone had plunged to 93 DU from approximately 300 DU in mid-July. More importantly, nearly all of the ozone in the layer between eight and 13 miles above the Earth's surface had been destroyed. In this critical layer, the instrument measured a record low of only 1.2 DU., having rapidly plunged from an average non-hole reading of 125 DU in July and August.

"These numbers mean the ozone is virtually gone in this layer of the atmosphere," said David Hofmann, director of the Global Monitoring Division at the NOAA Earth System Research Laboratory. "The depleted layer has an unusual vertical extent this year, so it appears that the 2006 ozone hole will go down as a record-setter."

Observations by Aura's Microwave Limb Sounder show extremely high levels of ozone destroying chlorine chemicals in the lower stratosphere (approximately 12.4 miles high). These high chlorine values covered the entire Antarctic region in mid to late September. The high chlorine levels were accompanied by extremely low values of ozone.

The temperature of the Antarctic stratosphere causes the severity of the ozone hole to vary from year to year. Colder than average temperatures result in larger and deeper ozone holes, while warmer temperatures lead to smaller ones. The NOAA National Centers for Environmental Prediction (NCEP) provided analyses of satellite and balloon stratospheric temperature observations. The temperature readings from NOAA satellites and balloons during late-September 2006 showed the lower stratosphere at the rim of Antarctica was approximately nine degrees Fahrenheit colder than average, increasing the size of this year's ozone hole by 1.2 to 1.5 million square miles.

The Antarctic stratosphere warms by the return of sunlight at the end of the polar winter and by large-scale weather systems (planetary-scale waves) that form in the troposphere and move upward into the stratosphere. During the 2006 Antarctic winter and spring, these planetary-scale wave systems were relatively weak, causing the stratosphere to be colder than average.

Appendix 1: The Laboratory in the News

As a result of the Montreal Protocol and its amendments, the concentrations of ozone-depleting substances in the lower atmosphere (troposphere) peaked around 1995 and are decreasing in both the troposphere and stratosphere. It is estimated these gases reached peak levels in the Antarctica stratosphere in 2001. However, these ozone-depleting substances typically have very long lifetimes in the atmosphere (more than 40 years).

As a result of this slow decline, the ozone hole is estimated to annually very slowly decrease in area by about 0.1 to 0.2 percent for the next five to 10 years. This slow decrease is masked by large year-to-year variations caused by Antarctic stratosphere weather fluctuations.

The recently completed 2006 World Meteorological Organization/United Nations Environment Programme Scientific Assessment of Ozone Depletion concluded the ozone hole recovery would be masked by annual variability for the near future and the ozone hole would fully recover in approximately 2065.

"We now have the largest ozone hole on record," said Craig Long of NCEP. As the sun rises higher in the sky during October and November, this unusually large and persistent area may allow much more ultraviolet light than usual to reach Earth's surface in the southern latitudes.

National Aeronautics and Space Administration

Airborne Dust Causes Ripple Effect on Climate Far Away 01.25.07

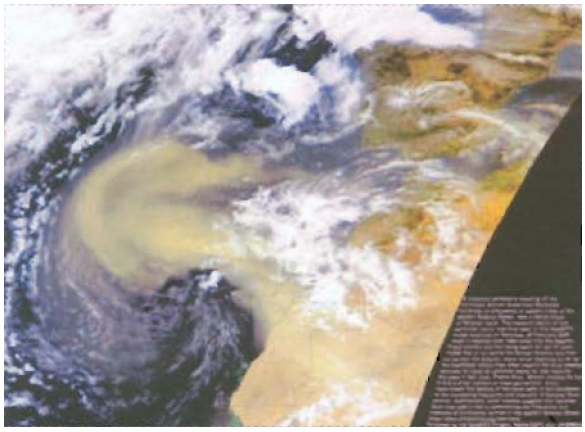
When a small pebble drops into a serene pool of water, it causes a ripple in the water in every direction, even disturbing distant still waters. NASA researchers have found a similar process at work in the atmosphere: tiny particles in the air called aerosols can cause a rippling effect on the climate thousands of miles away from their source region.

Image below: Dust from Africa's Saharan Desert lingers in high altitudes as it crosses the Atlantic Ocean. This picture was taken from an aircraft northeast of Barbados in 2006. Cumulus clouds can be seen poking through the tops of the dust layer, which is seen as a milky white haze. Credit: NOAA

The researchers found that dust particles from the desert regions in northern Africa can produce climate changes as far away as the northern Pacific Ocean. Large quantities of dust from North Africa are injected into the atmosphere by dust storms and rising air. Airborne dust absorbs sunlight and heats the atmosphere. The heating effect ripples through the atmosphere, affecting surface and air temperatures as the dust travels.

"These highs and lows in air temperatures caused by radiation-absorbing aerosols can lead to 'teleconnection', which refers to changes in weather and climate in one place caused by events happening far away, often more than half way around the globe," said William Lau, Chief of the Laboratory for Atmospheres at NASA's Goddard Space Flight Center, Greenbelt, Md., and author of a study published last fall in the American Meteorological Society's Journal of Climate. "North African dust can be lifted high into the atmosphere by storms and then transported across the Atlantic and Caribbean, where its effect can be far-reaching." From a climate point of view, aerosols can block solar radiation (incoming heat and light from the sun) from hitting the Earth's land surface. When sunlight is blocked, it can cause the Earth's surface to cool, and/or the aerosols can absorb solar radiation and cause the atmosphere in the vicinity of the airborne dust to get warmer.

Image below: A massive sandstorm blowing off the northwest African desert blanketed hundreds of thousands of square miles of the eastern Atlantic Ocean with Saharan Sand. It was seen from the SeaWiFS satellite on Feb. 26, 2000, as it reached 1,000 miles into the Atlantic Ocean. Credit: NASA GSFC and ORBIMAGE



According to Lau, researchers thought for years that heat changes in the atmosphere from aerosols only caused local changes in temperatures. However, "we now know they may cause more than local changes to climate," he said. Lau's computer model indicates that the heat changes caused by aerosols affect the heat balance in the air over North Africa. That change in heat creates large waves in the atmosphere that ripple as far away as Eurasia and the North Pacific.

Researchers have created complex numerical models to simulate the "still waters" of the atmosphere during North African spring – a season when climate conditions are relatively calm with light winds and light rain.

Lau's team carried out a numerical model experiment that included aerosol forcing, and then another one with identical initial conditions and lower boundary conditions, except that the :aerosol forcing is removed. By comparing the weather patterns in the two experiments, they can deduce the effect of aerosol forcing. They observed the aerosols made an impact far away from their source region. In setting up their experiment, the researchers chose the northern Sahara Desert in springtime, when the weather conditions are relatively calm, allowing aerosols, like dust, to build up more in air.

An "atmospheric teleconnection" happens when unusual patterns of air pressure and air circulation happen in one place, and the energy is dispersed over large distances around the globe to other places. An atmospheric teleconnection can lead to changes in sea level pressure and temperature around the world. This study saw changes from North Africa through Eurasia to the North Pacific.

Most interesting, Lau's team found that North African-dust teleconnection led to strong cooling over the Caspian Sea (a land-locked body of water between Russia and Europe) and warming over central and northeastern Asia, where man-made aerosol concentrations are low.

"Elevated aerosols in large quantities such as dust from North Africa, or biomass burning may have global impacts," said Lau. "We expect to observe more and more real-world examples of this teleconnection phenomenon with the high volume of aerosols generated by nature and human activities around the world."

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